Opportunities for CO2 Storage in the Swedish Sector of the Baltic Sea

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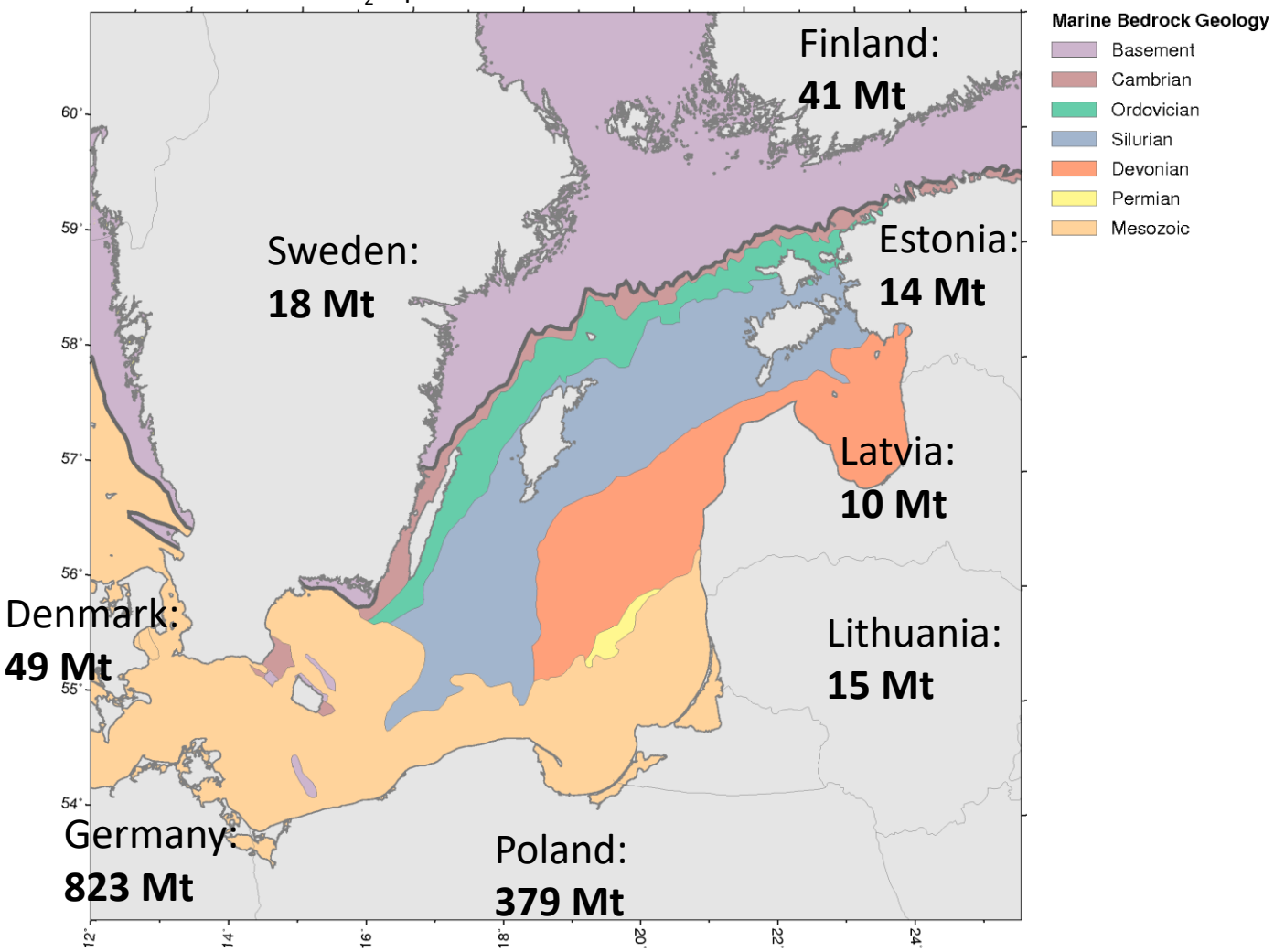
SGU Geological Survey of Sweden

CO_2 emissions in the Baltic region

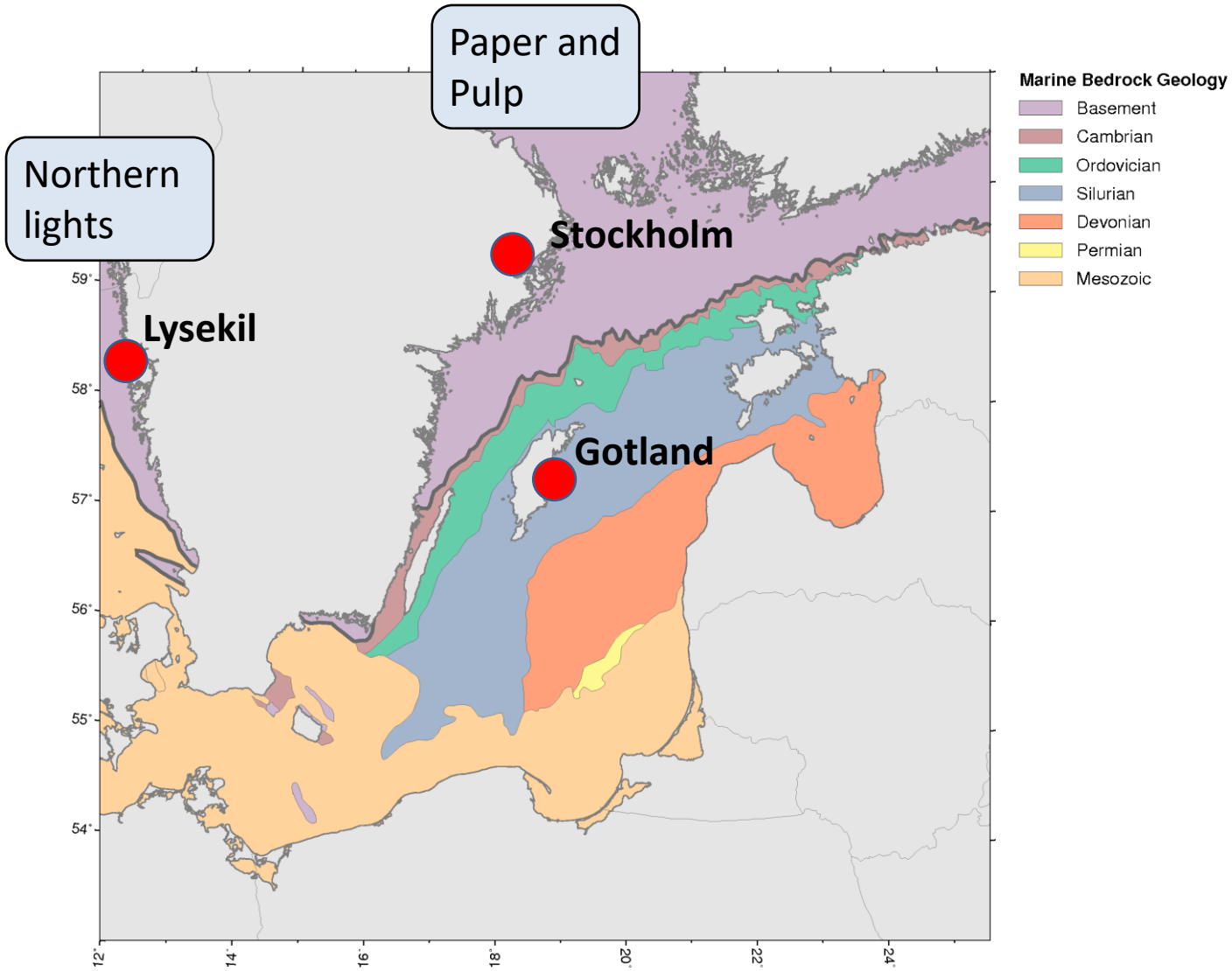
- Although CO_2 emissions around the Baltic Sea are reducing, they are still significant.
- One option to reduce CO_2 emissions is CO_2 Capture and Geological Storage (CCGS).

Total Net emissions CO_2 equivalent 2019 EEA website



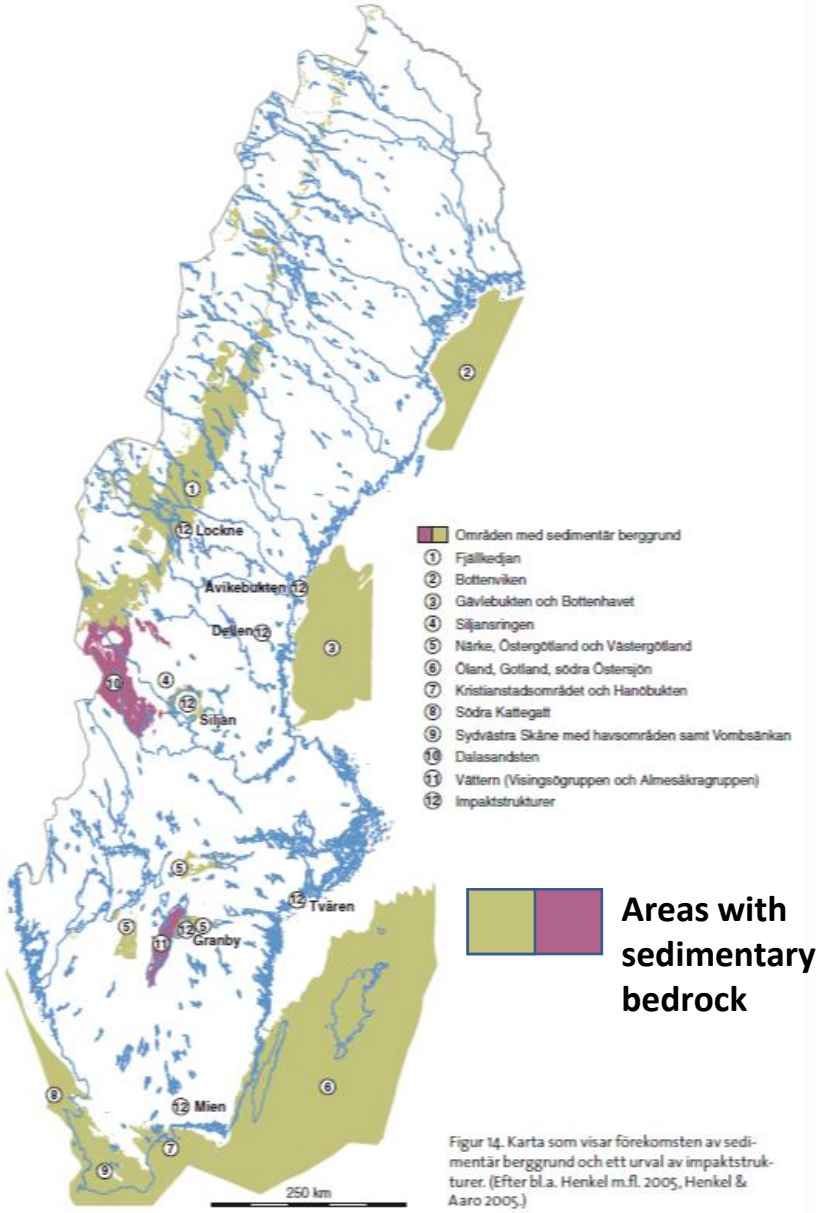
CO_2 emissions in the Baltic region

- Increasing interest in CO_2 capture and storage in Sweden. For example:
  - **Stockholm Exergi:** Pilot Capture plant in Värtan, Stockholm (Bio CCS – BECCS).
  - **PREEM:** Pilot capture plant in Lysekil refinery.
- Presently, storage in Norway envisioned in these projects.



Potential for CCS within Sweden

- Based on previous assessments, sedimentary rocks are likely to be the most suitable for CO_2 storage in Sweden.



Figur 14. Karta som visar förekomsten av sedimentär berggrund och ett urval av impaktstrukturer. (Efter bl.a. Henkel m.fl. 2005, Henkel & Aaro 2005.)

Erlström et al., 2011

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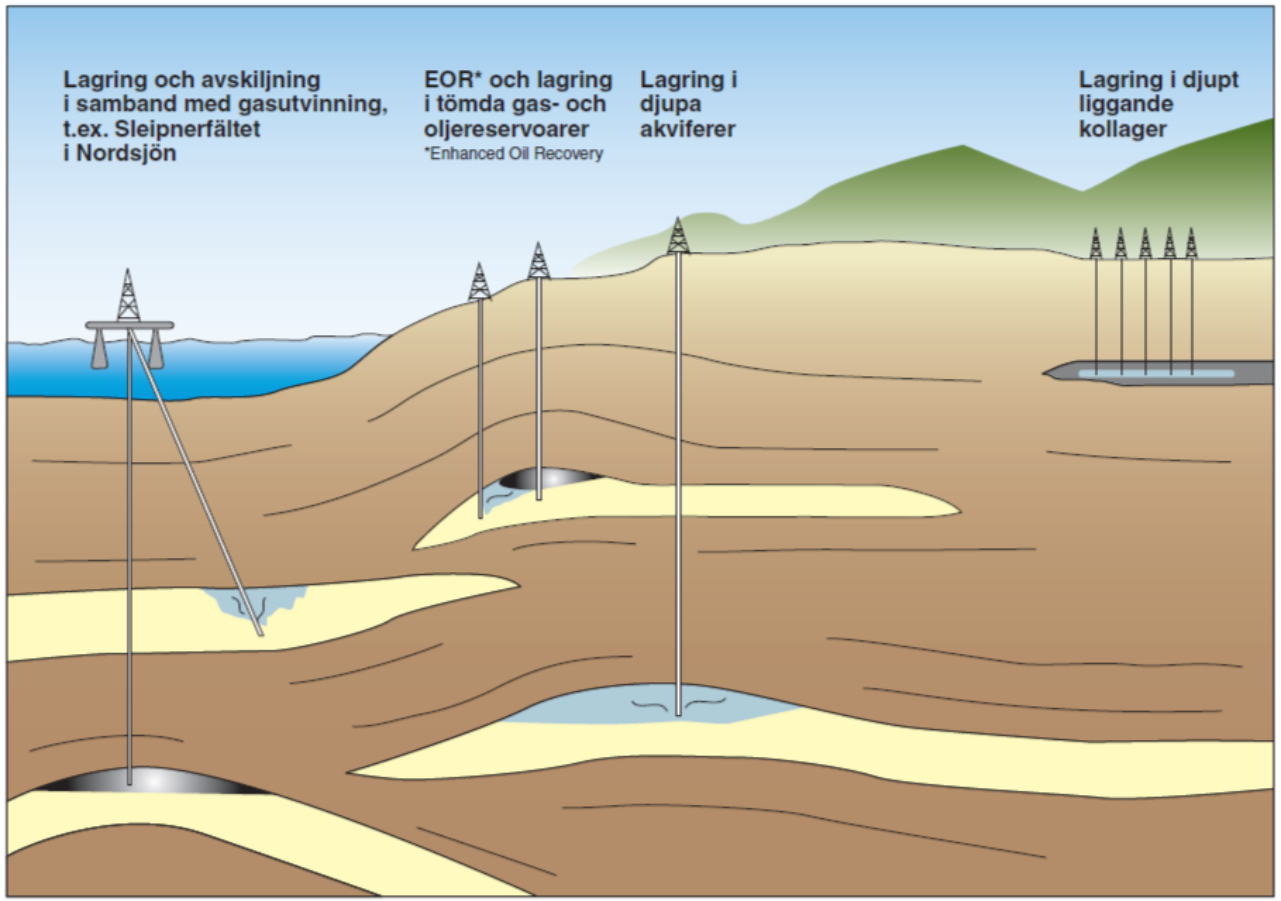

Figur 1. Olika lagringsmöjligheter i sedimentär berggrund (modifierad från Erlström m.fl. 2011).

Mortensen et al., 2017

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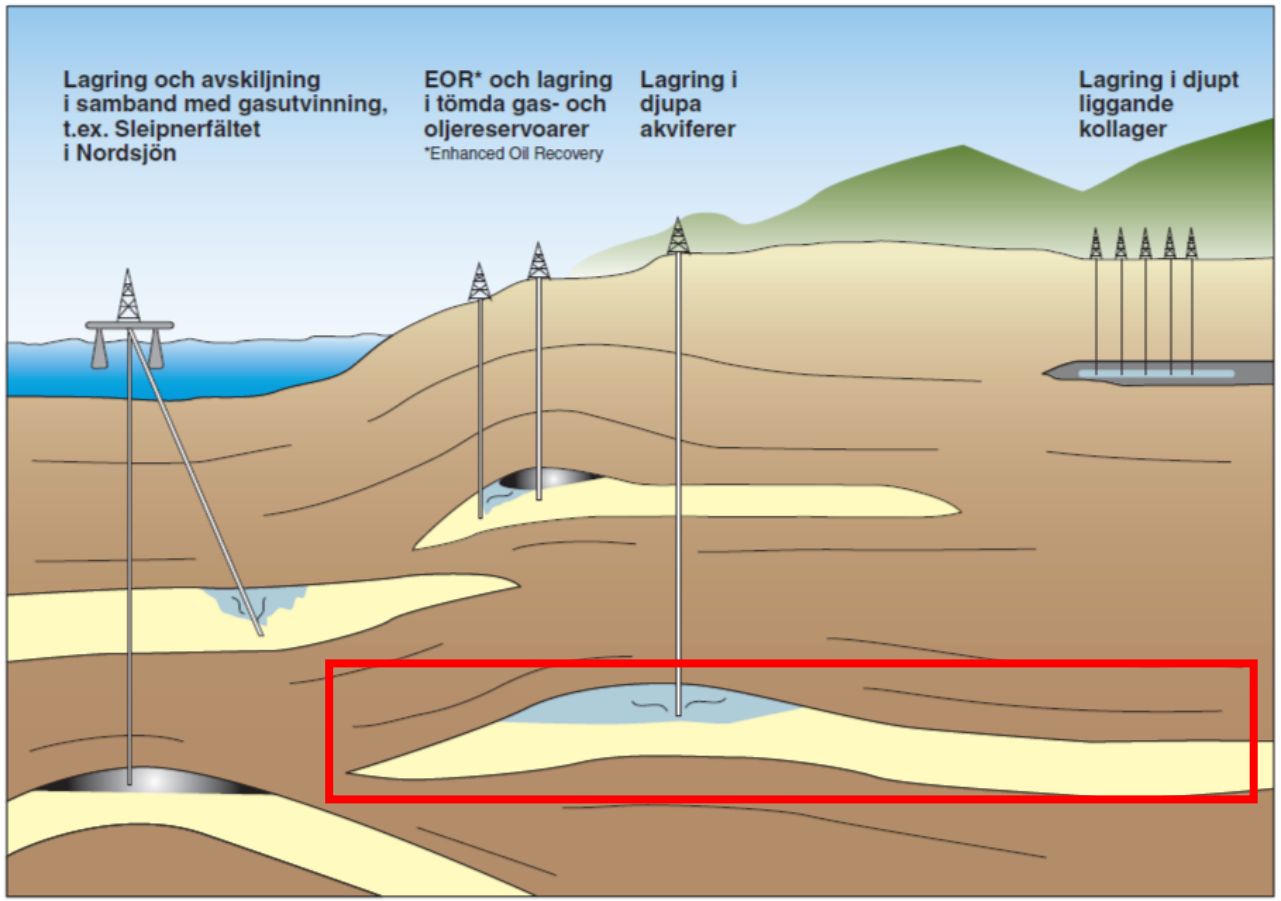
- Storage within deep saline aquifers deemed to have the greatest potential.



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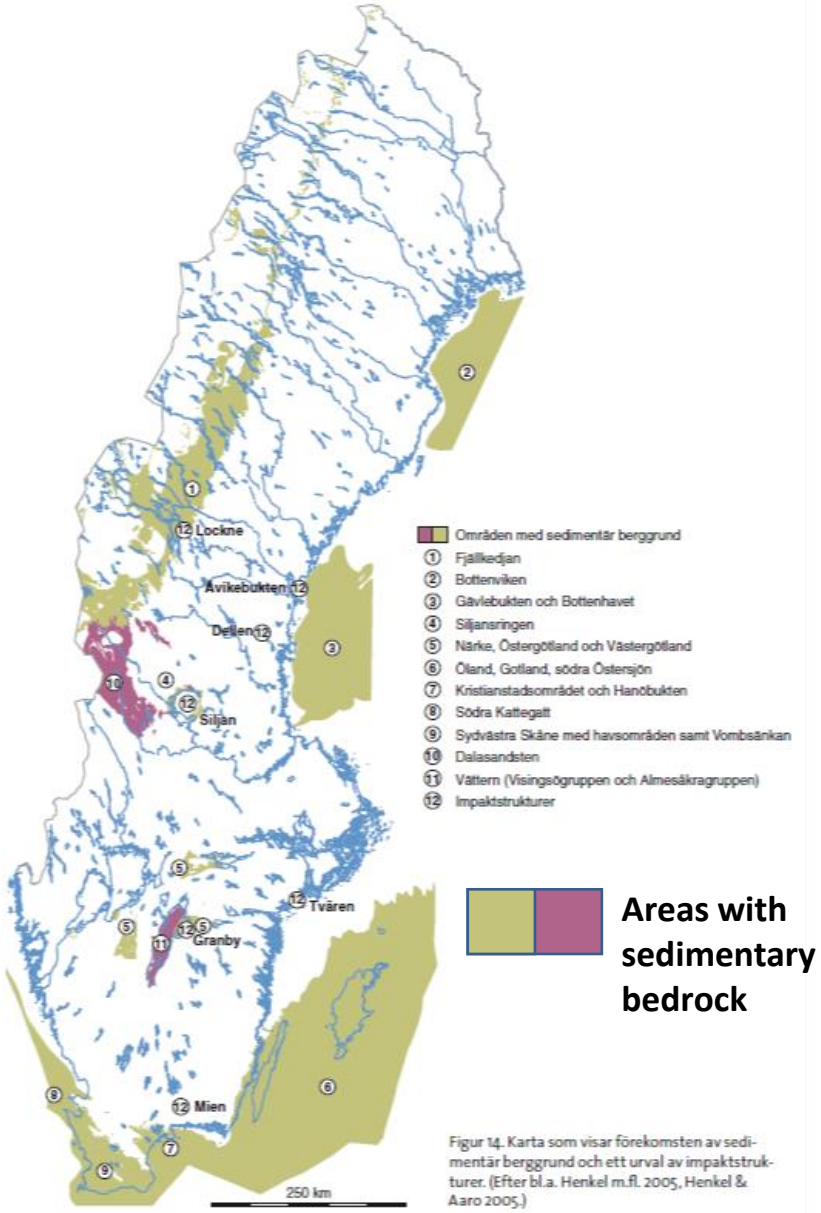
Mortensen et al., 2017

Potential for CCS within Sweden

- Two areas identified to have the greatest potential:
  - Baltic Sea Basin.
  - Southern Skåne.



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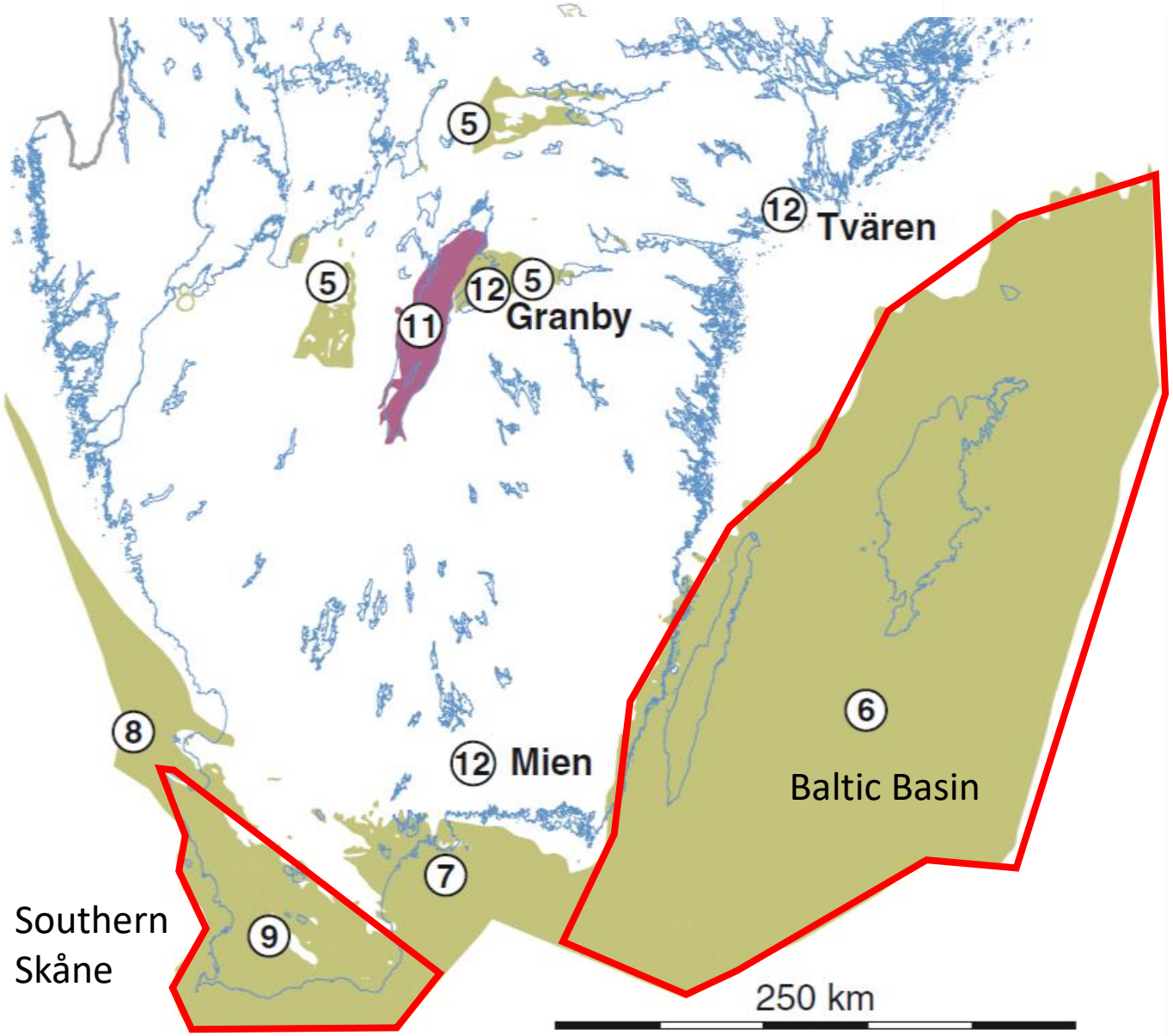
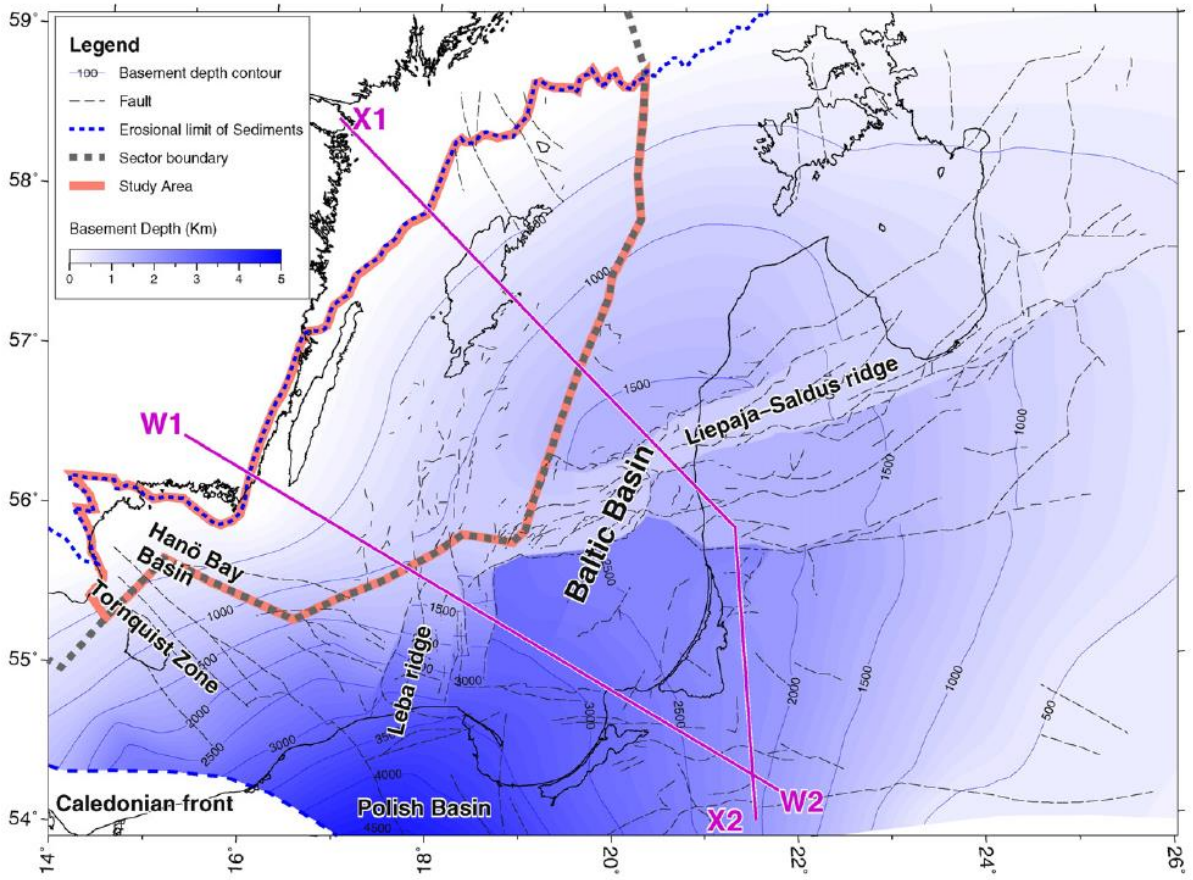


Erlström et al., 2011

Baltic Basin



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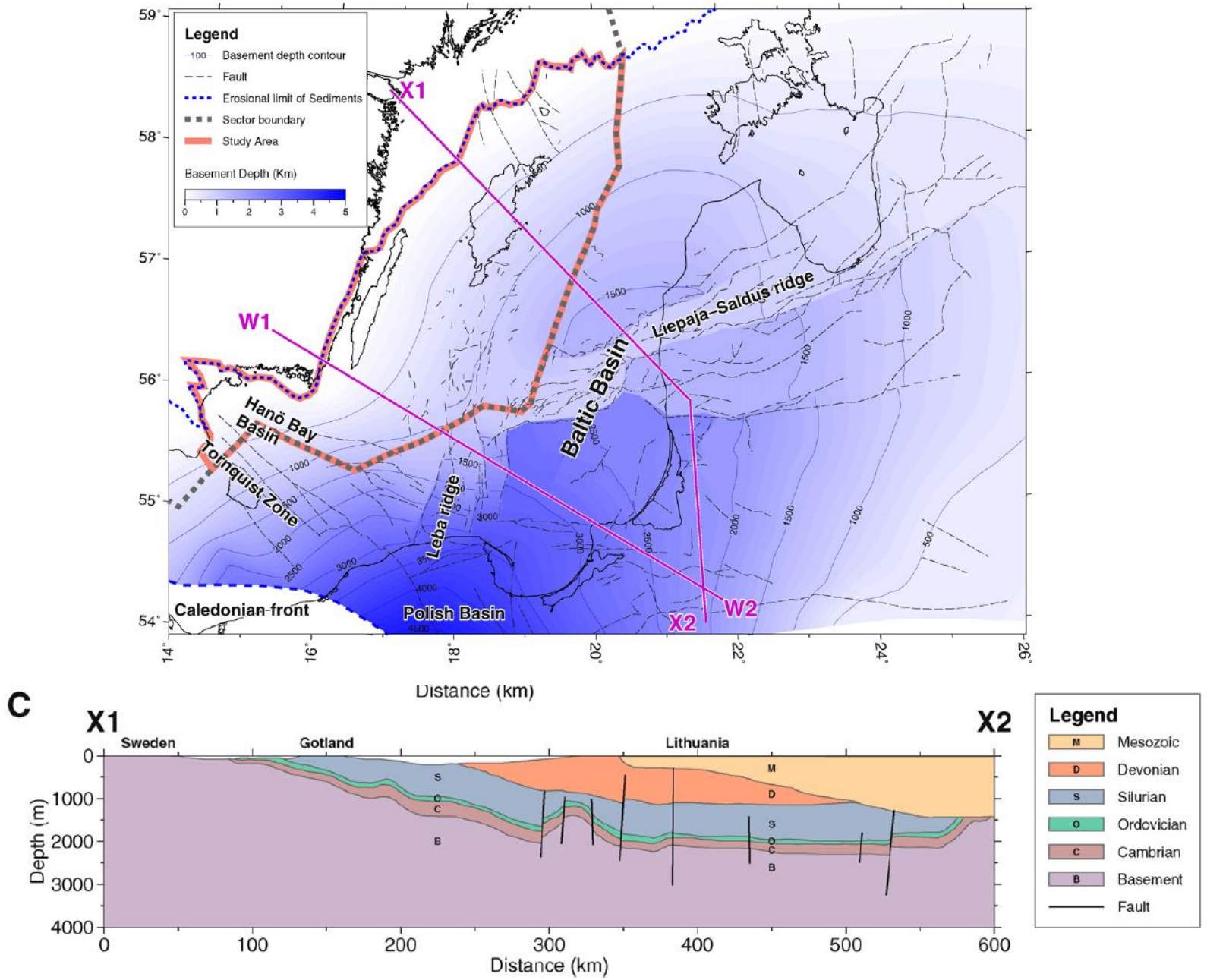

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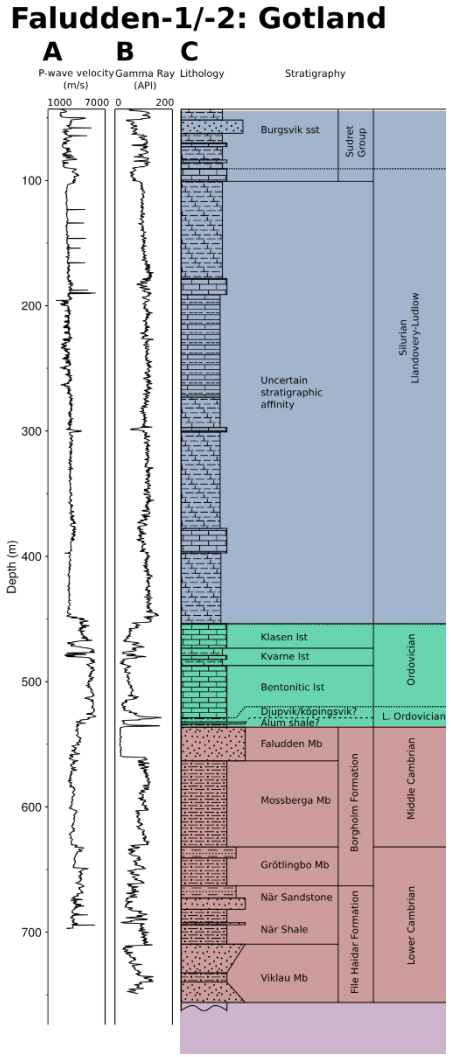
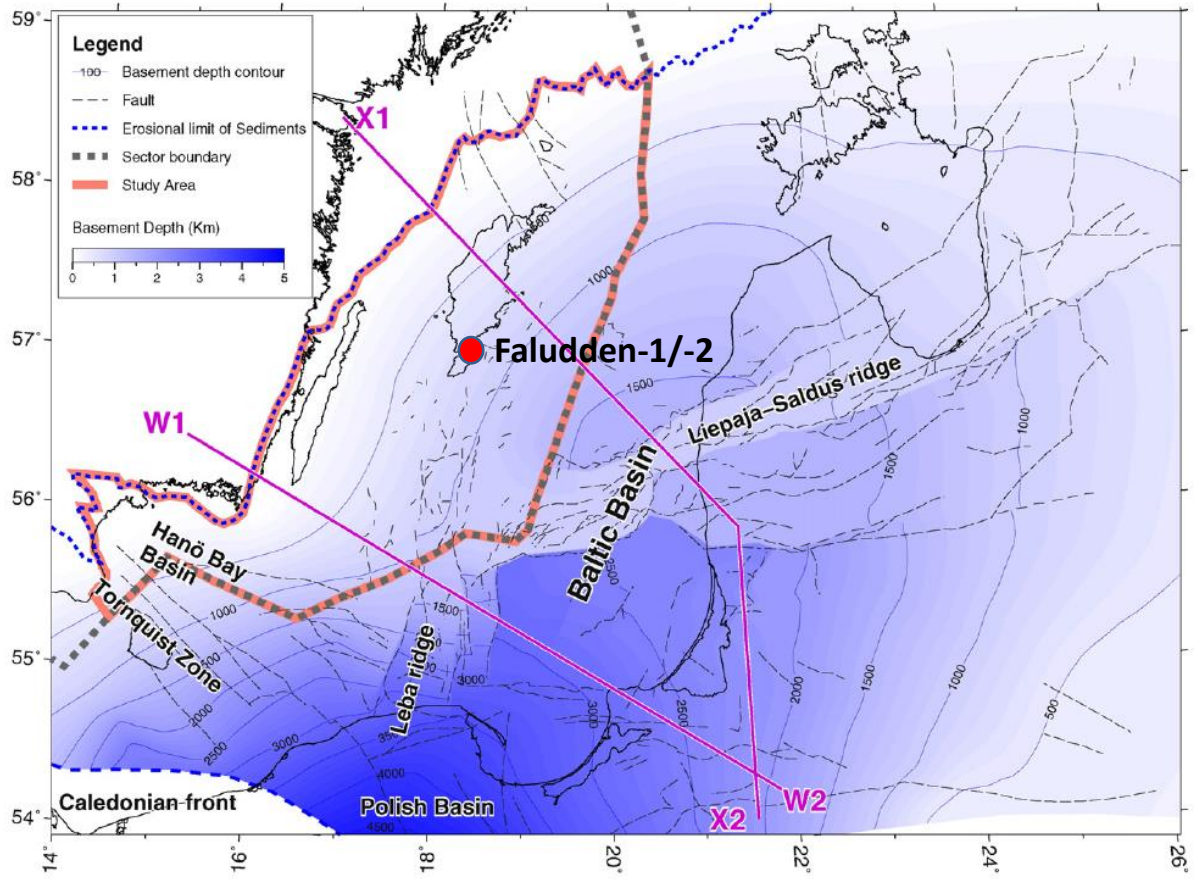
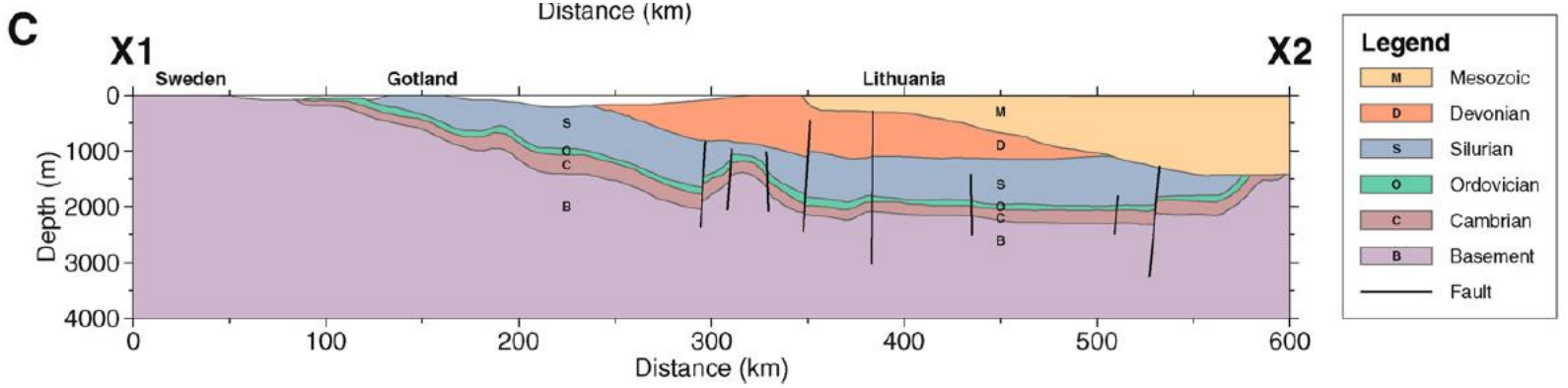


Silurian

Ordovician

Cambrian





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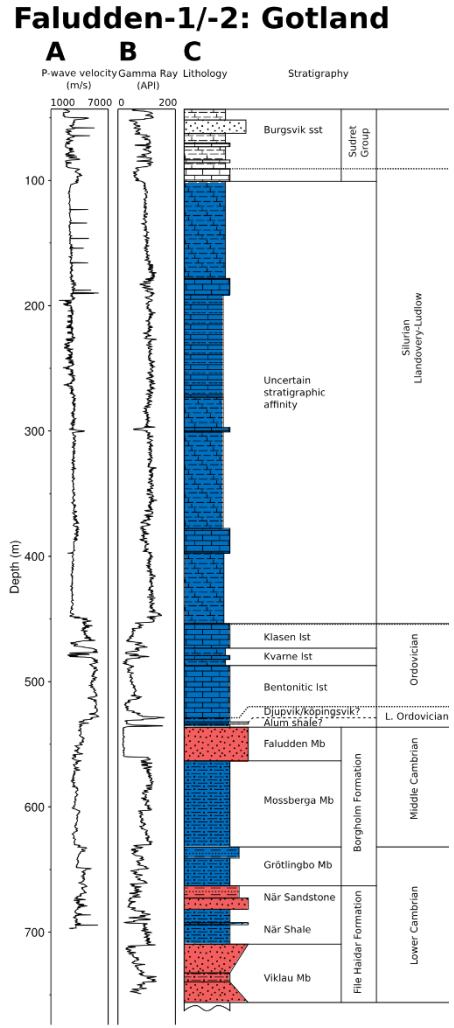
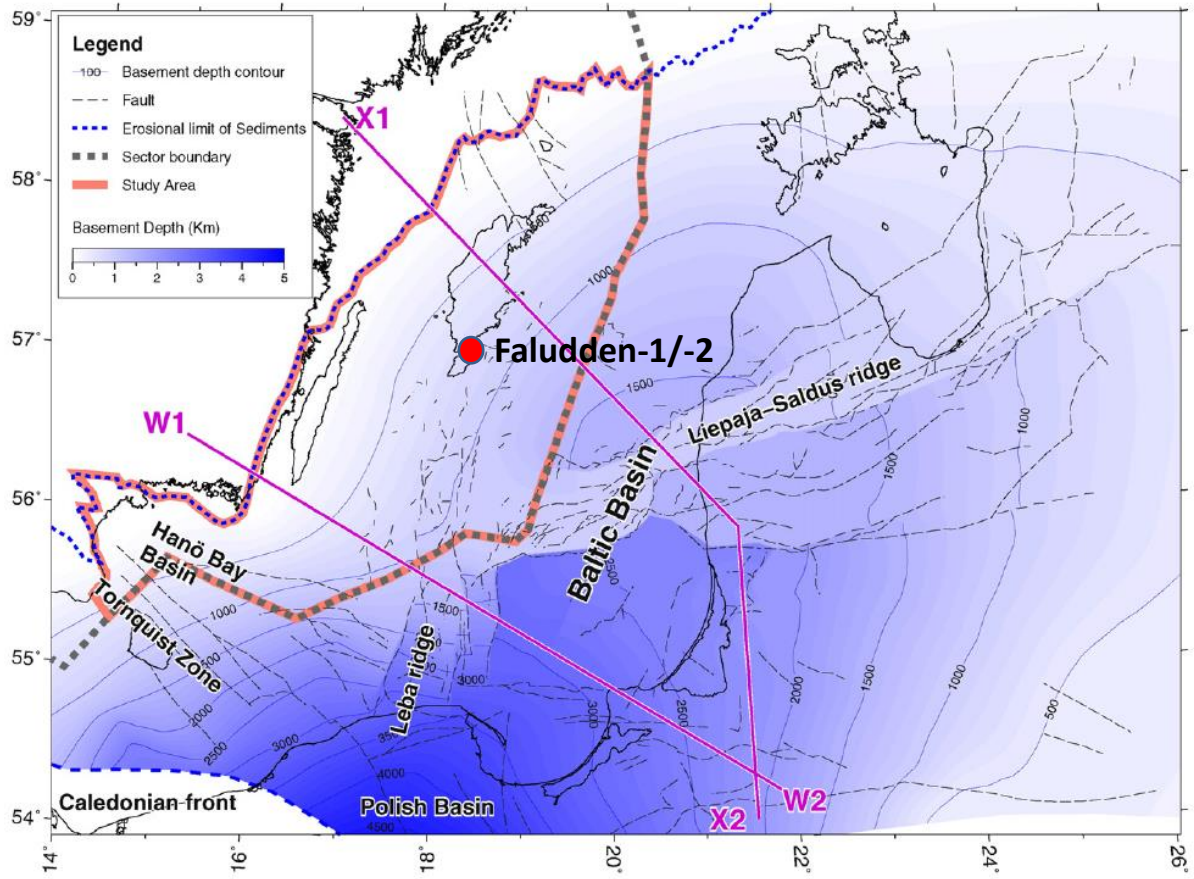
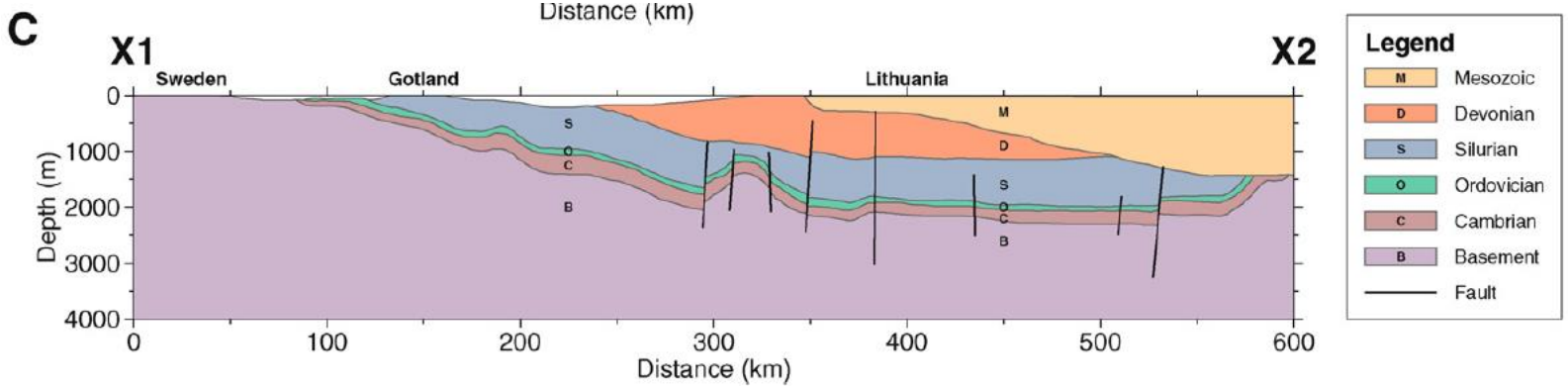


Reservoir

Caprock





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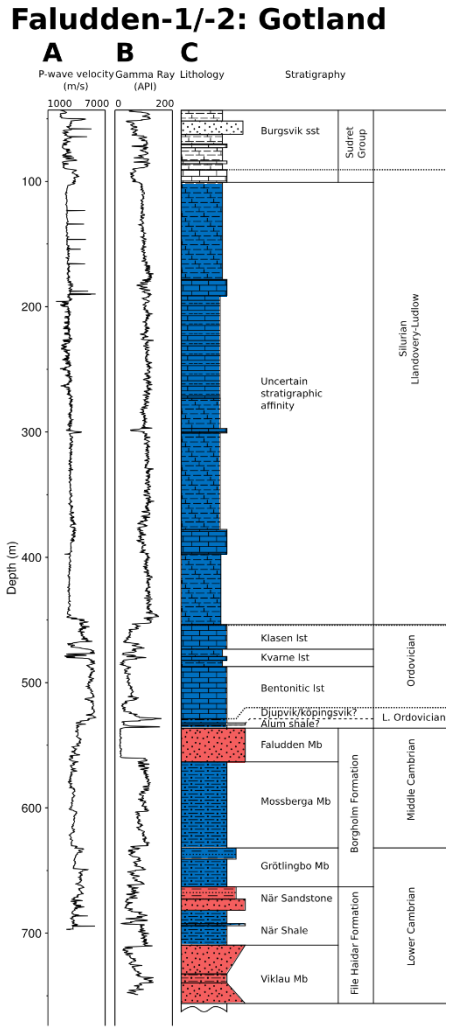

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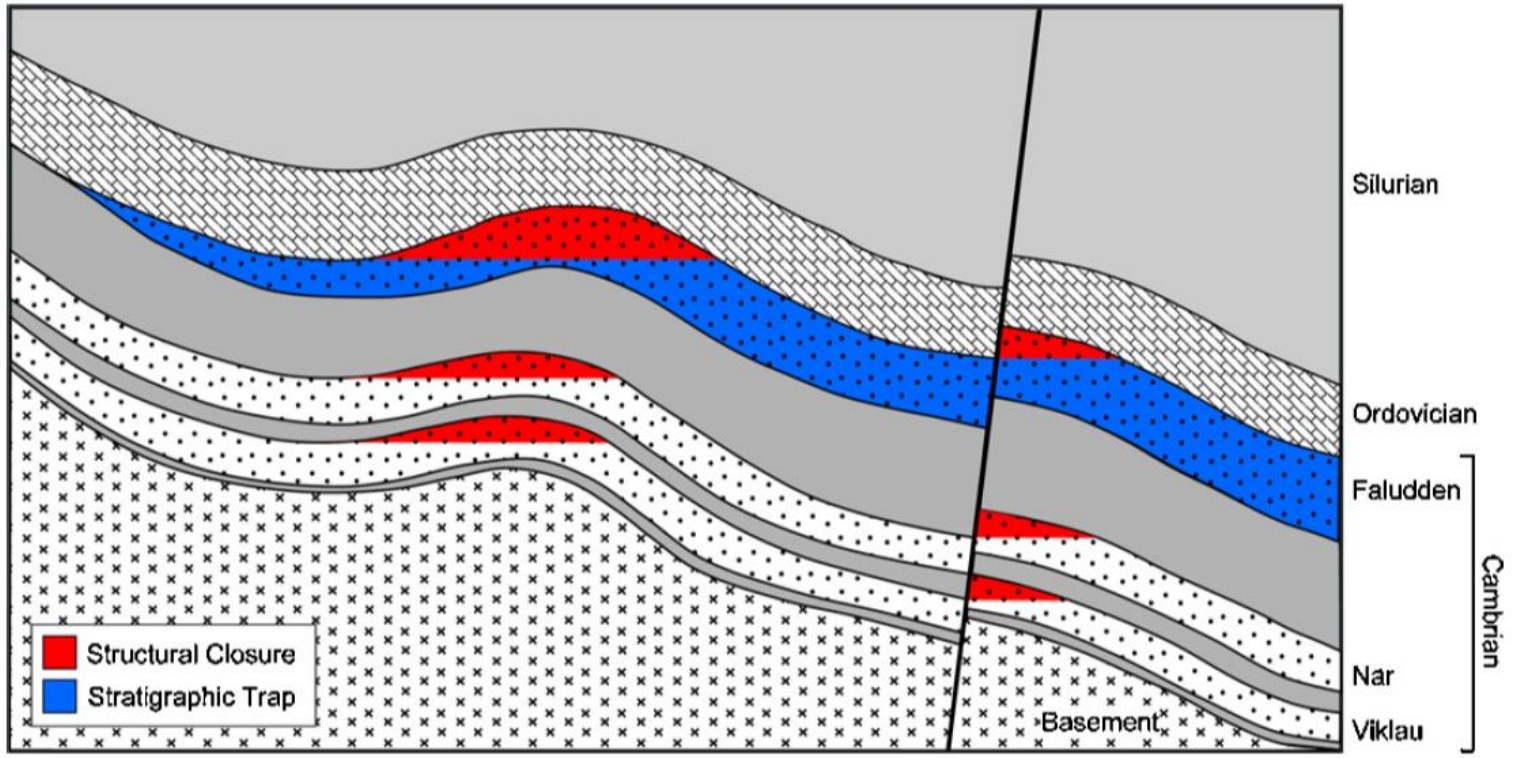
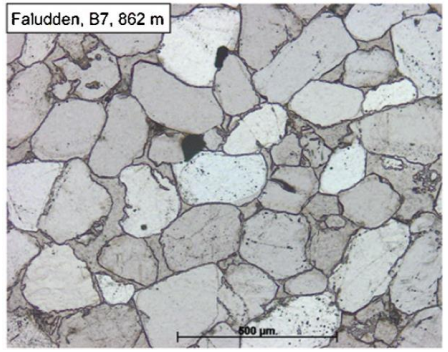
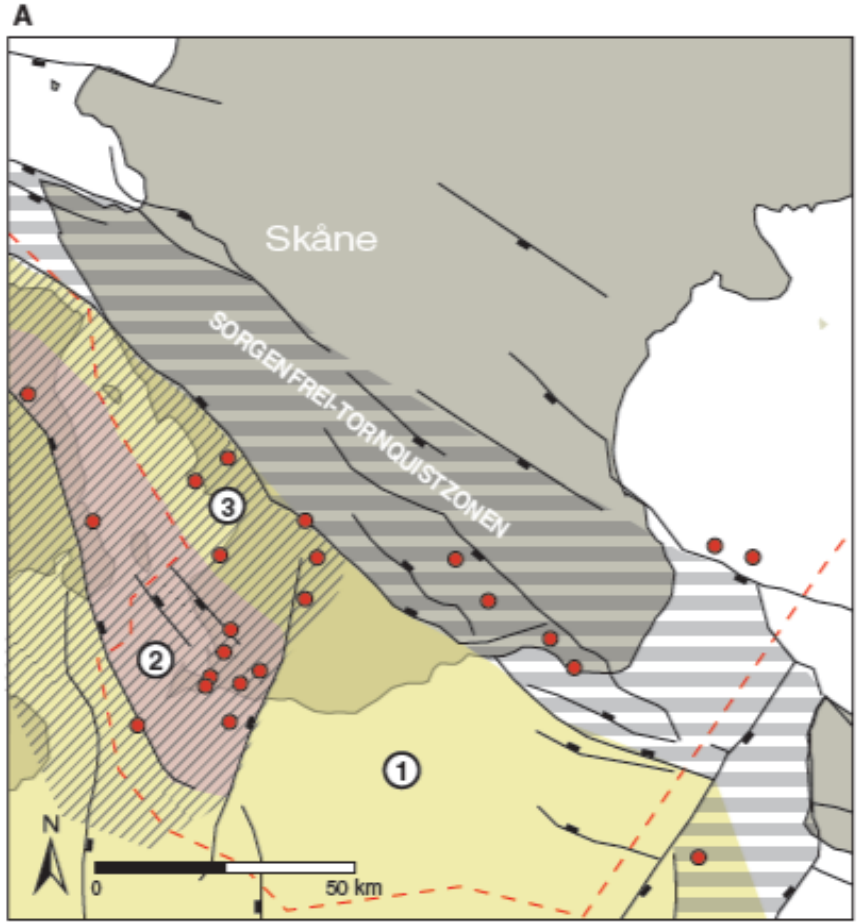




Faludden reservoir:

- Regionally extensive, shallow marine reservoir.
- Porosity 10-16%
- Permeability 200 - 400 mD
- Thicknesses in excess of 50m to the south east, pinches out to the north west.

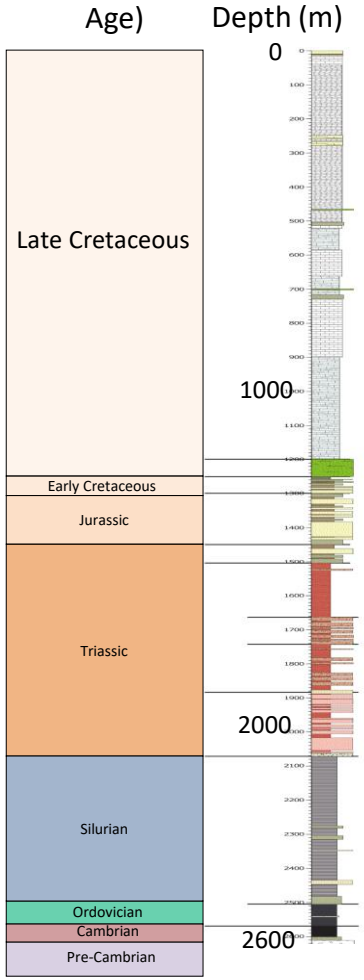
Southern Skåne

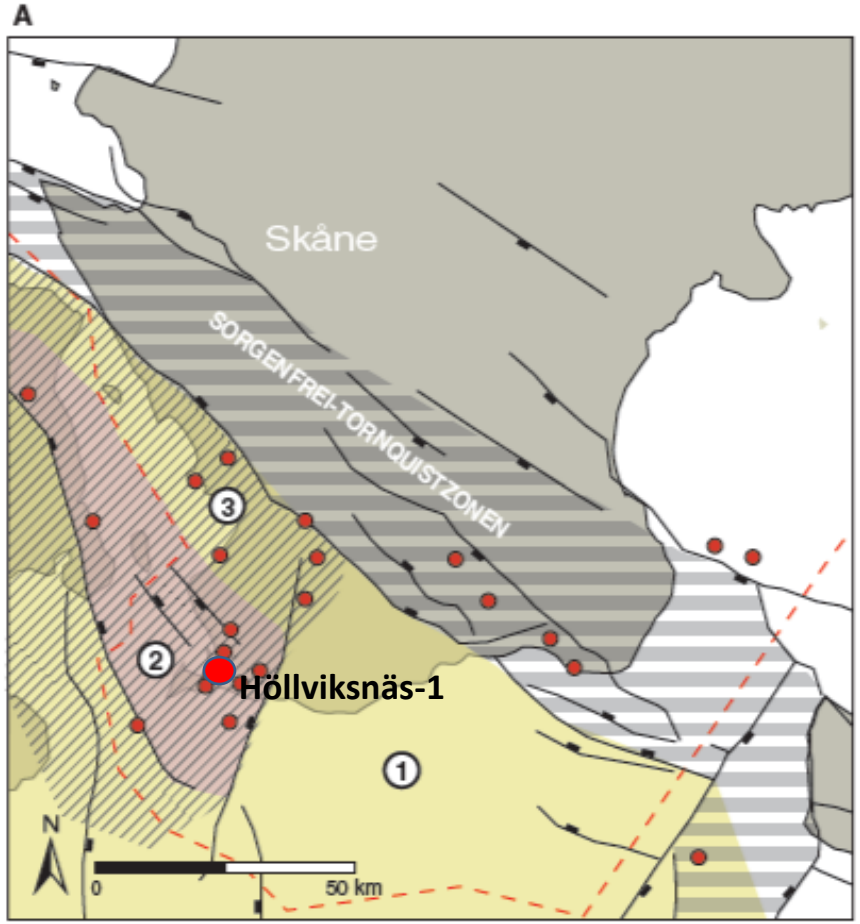


Mortensen et al., 2017

Southern Skåne

Höllviksnäs-1





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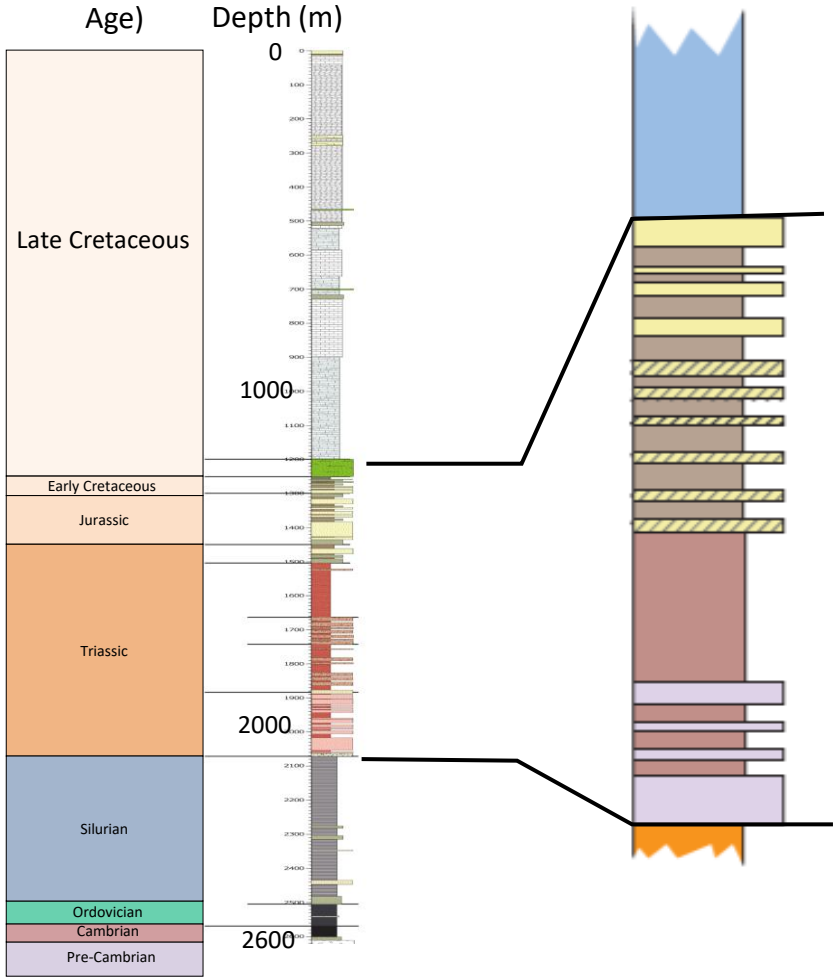
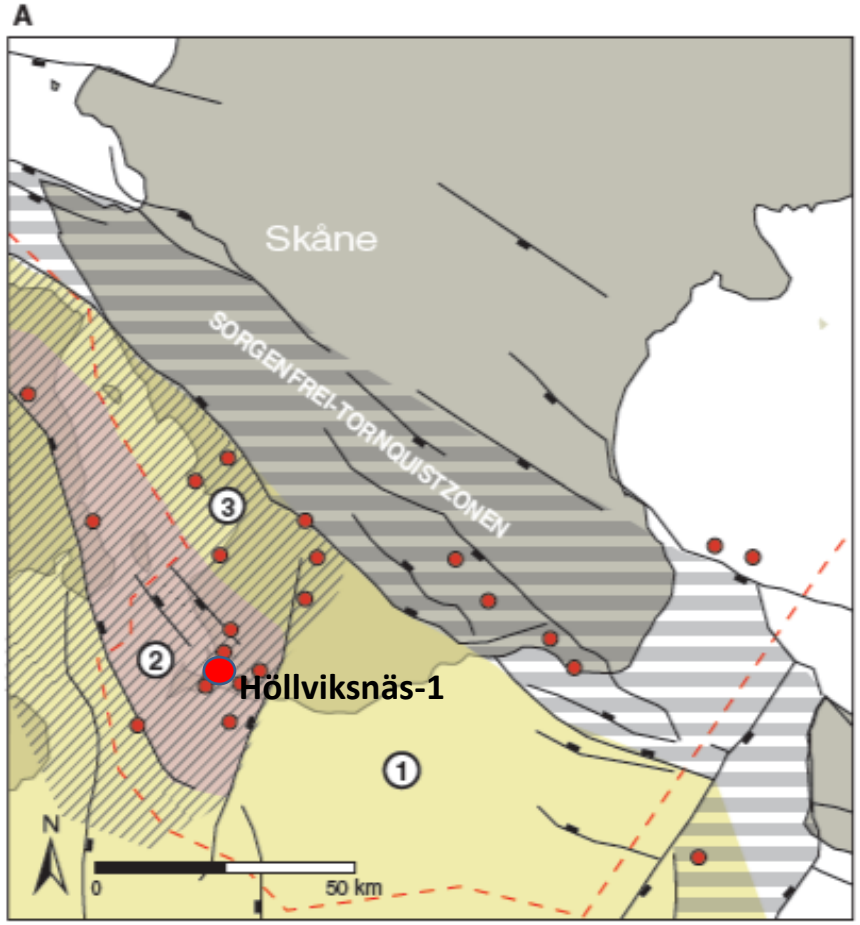


Arnager greensand and other Lower cretaceous sands

Höganäs and Rya formations

Bunter and Ljunghusen sandstones



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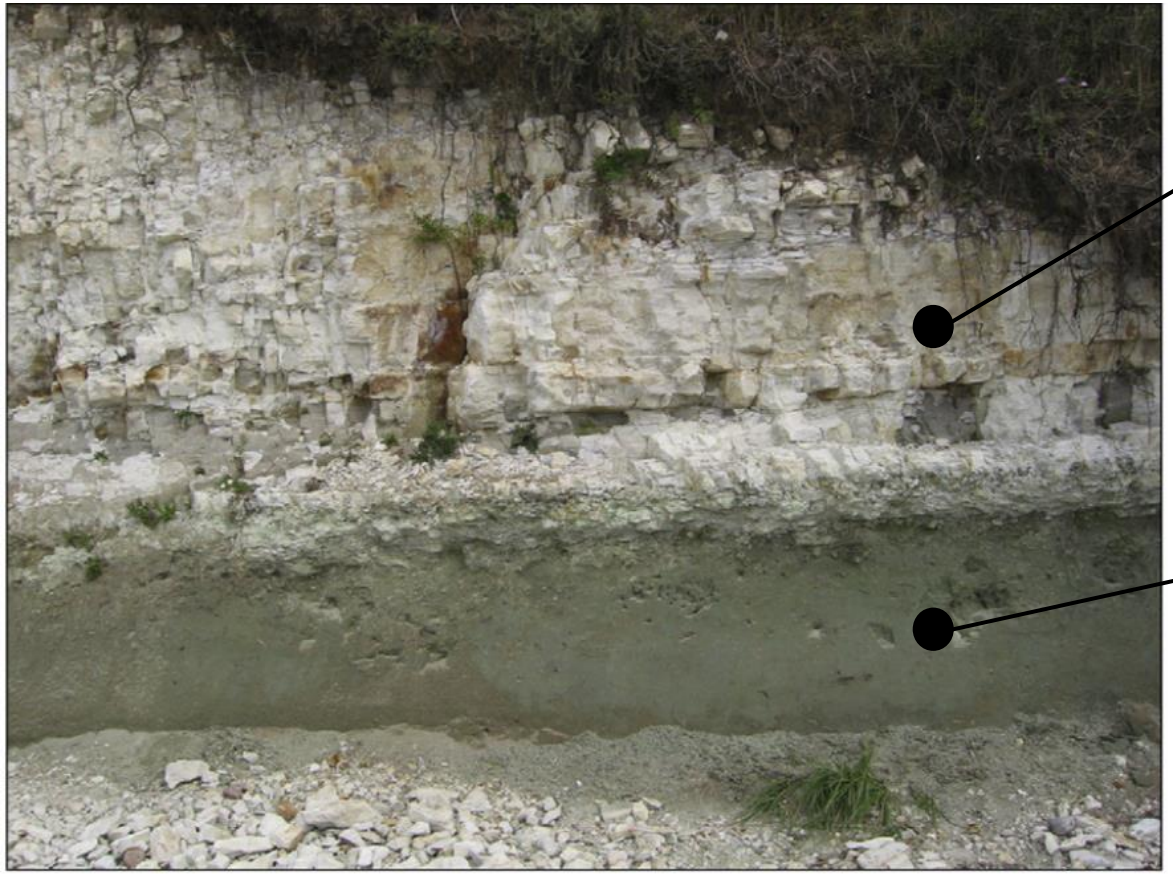

Hart et al., 2011

Arnager Limestone:

Arnager Greensand:

- Shallow marine sandstone, regionally extensive.
- 17 – 56 m thickness.
- Porosities 20-30%
- Permeabilities up to several Darcies.

Estimated Storage capacities

Depth (m)	Depth (m)	Thickness (m)	N/G	Porosity (%)	Perm (mD)	Theo. Capacity (Mt)	Eff. Cap. EU GeoCapacity (Mt)	Eff. Cap. US DOE, 2% (Mt)
Faludden sst	830	45	0.9	14	147	37271	5591 (15%)	745
När sst	817	36	0.65	10	50	21294	3194 (15%)	426
Viklau sst	865	57	0.65	8	30	27631	4145 (15%)	553
Arnager Greensand	946	39	0.8	26	681	26050	7815 (30%)	521
L.Cret.sands A	965	29	0.65	25	200	16523	2478 (15%)	330
L.Cret.sands B	776	200	0.65	25	200	5753	288 (5%)	115
Höganäs-Rya	976	180	0.51	23	200	27127	2713 (10%)	543
Bunter sst	1509	137	0.67	12	300	8268	248 (3%)	165

Baltic Basin

Southern Skåne

Mortensen et al., 2017

- A number of Capacity estimations have been made over the last 10 years utilizing a range of methodologies, including (Erlström et al., 2011; Vernon et al., 2013; Sopher et al., 2014; Mortensen et al., 2017 etc).

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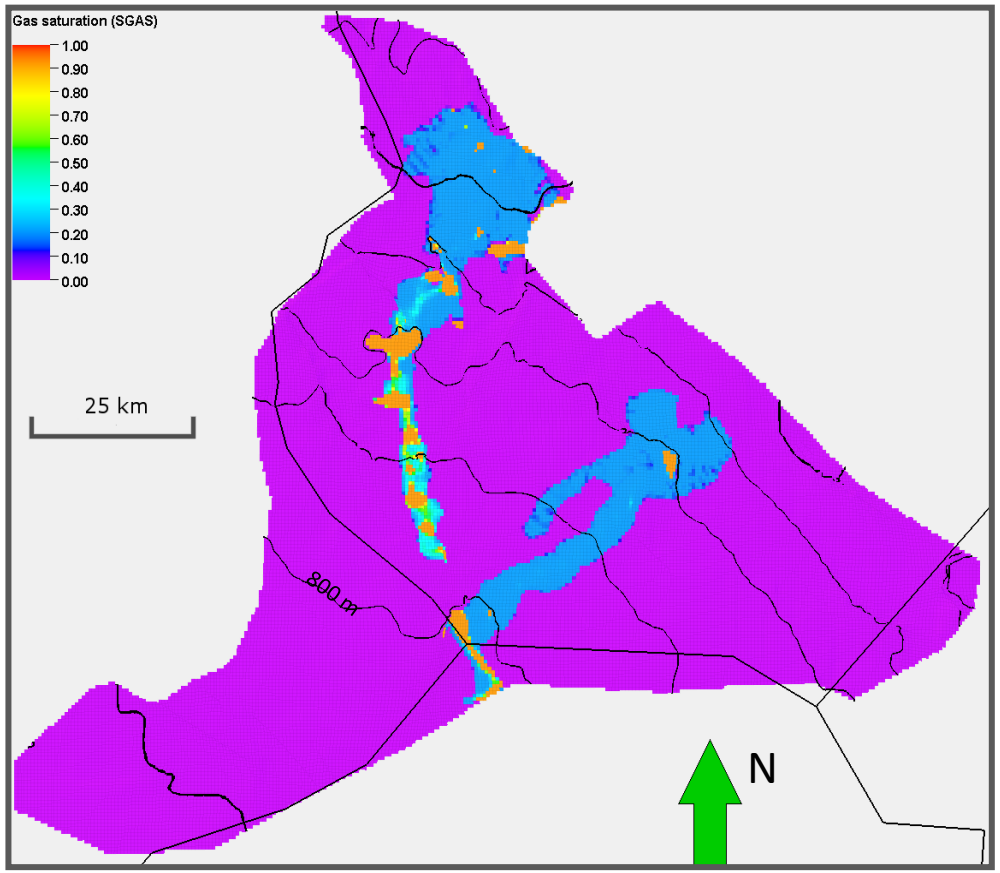
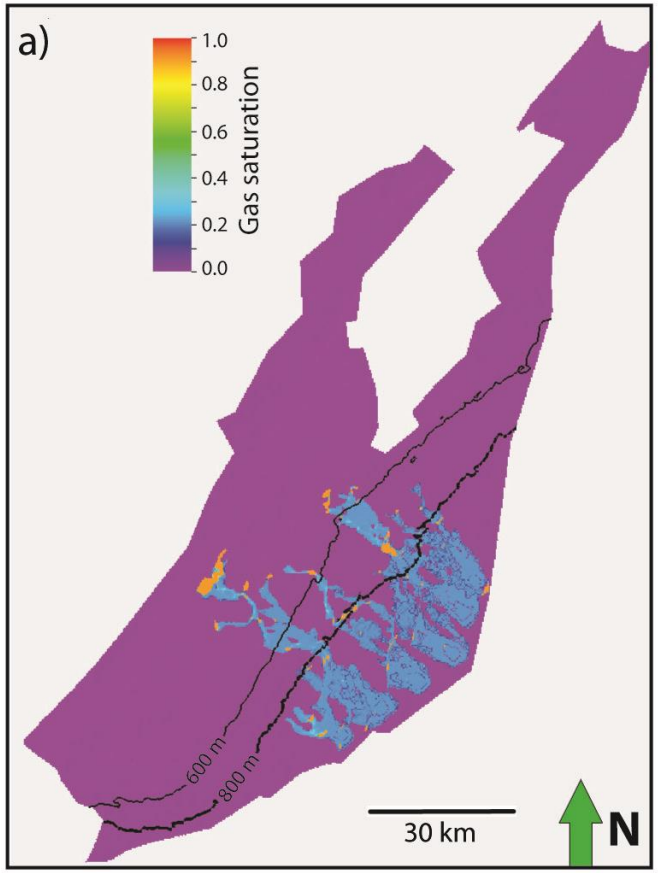
- However, Faludden Sandstone and the Arnager Greensand have been consistently identified as the most suitable reservoirs for storage.

Estimated Storage capacities

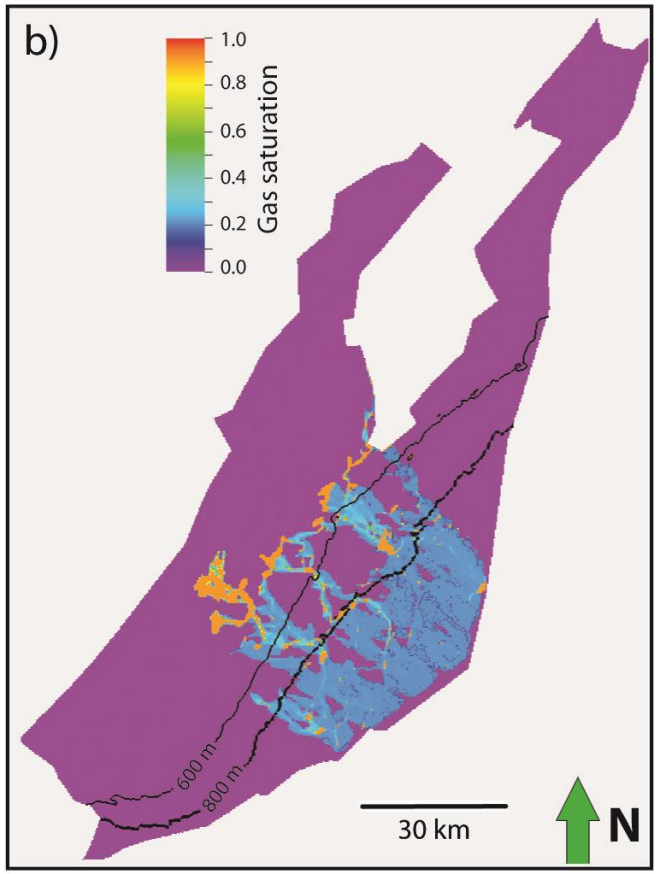
Dynamic Reservoir Modelling
Mortensen et al., 2016



Arnager Greensand: 250 Mt CO2/100 years
4 wells: 0,5-1 Mt/year



Faludden: 250 Mt/50 years
6 wells: 0,5-1 Mt/year



Faludden: 500 Mt/100 years
6 wells: 0,5-1 Mt/year

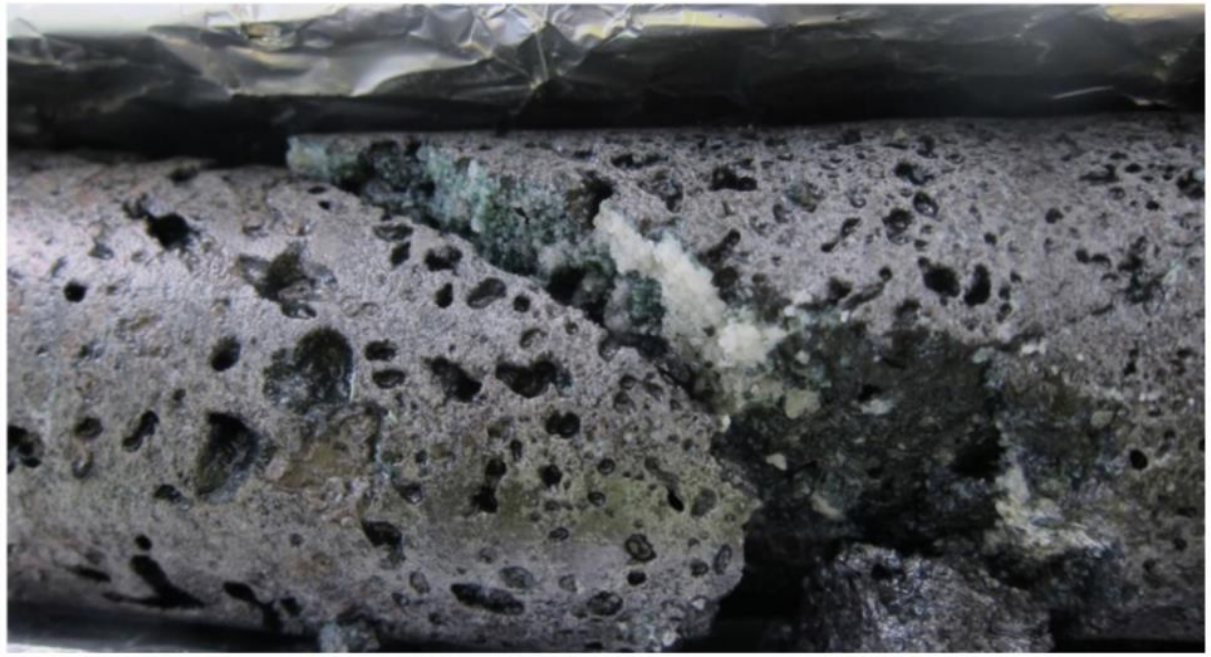
CCS within Basic rocks in Sweden

CO2 INSURANCE

Luleå Tekniska Universitet

Project to investigate Mineral trapping of CO_2 within basic rocks in Sweden, started 2021.

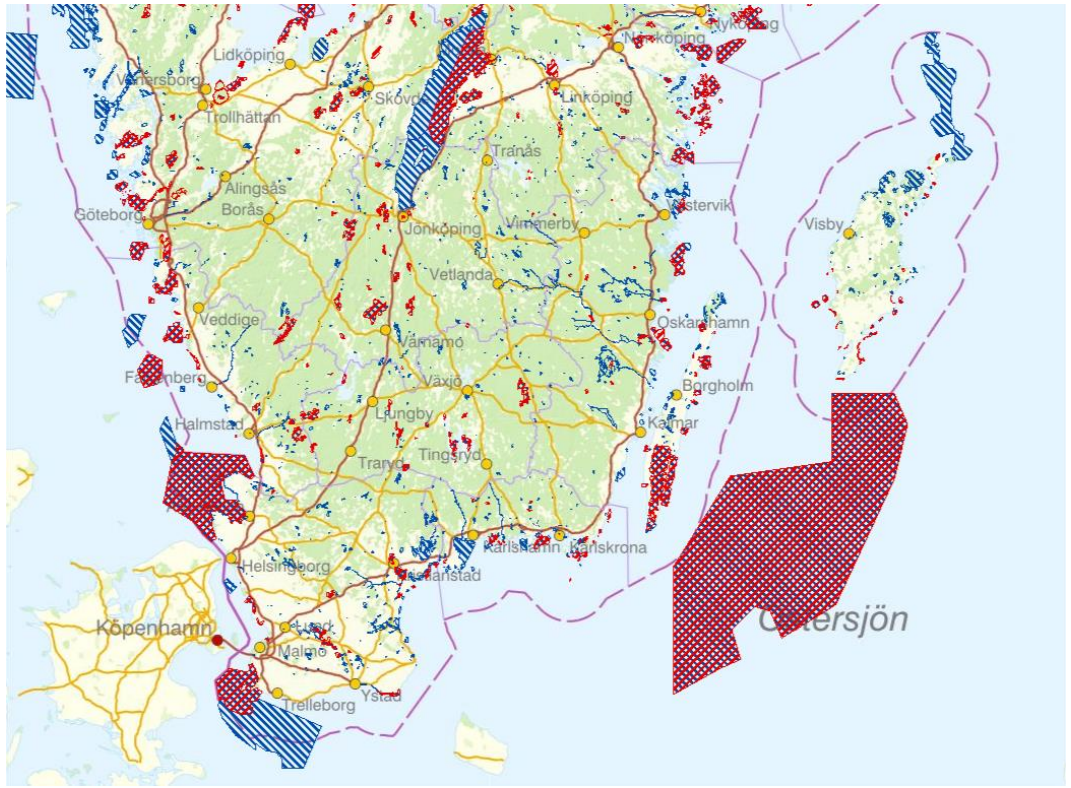
https://www.ltu.se/research/subjects/Malmgeologi/Forskningsprojekt/CO2-INSURANCE



Basalt from Iceland (Creative commons)

Challenges for CCS in Sweden

- Limited opportunities for storage within structural traps within both the Faludden and Arnager Greensand reservoir in Swedish territory.
- Currently there is a ban on hydrocarbon extraction in Sweden.
- Need for new modern seismic and well data from both Skåne and the Baltic Sea.
- Lengthy permitting procedure to acquire new marine data. Can take between 1-3 years to get permission to collect new data.
- Permission required to distribute/publicise marine geophysical data within Swedish marine territory (0-20km from the coastline).
- Natura 2000 protection zones over some areas which are interesting for potential CO_2 storage.



Natura 2000 protected areas

Summary

- Good opportunities exist for industrial scale CCS within the Swedish parts of the Baltic Sea.
  - Faludden reservoir in the Baltic Basin.
  - Arnager Greensand in southern Skåne.
- However, acquisition of new data and additional technical work is required to further evaluate these opportunities as well as the associated risks.

Find out more or contact us:

https://www.sgu.se